

Intercomparison of models for simulating timothy yield in northern countries

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Background

- Forage-based livestock and dairy production are the economic backbone of agriculture in many northern countries.
- In northern Europe and eastern Canada, forage grasses for silage are commonly grown for 2-4 years or longer in rotations with cereal crops and harvested 2-3 times per year.
- In those regions, timothy (*Phleum pratense* L.) is one of the most widely grown forage grass species.
- Models that simulate the growth and nutritive value have been developed for timothy, but the performance of different models has not been compared so far.



Photo: Perttu Virkajärvi (Luke)

Timothy
(*Phleum pratense* L.)

Research questions

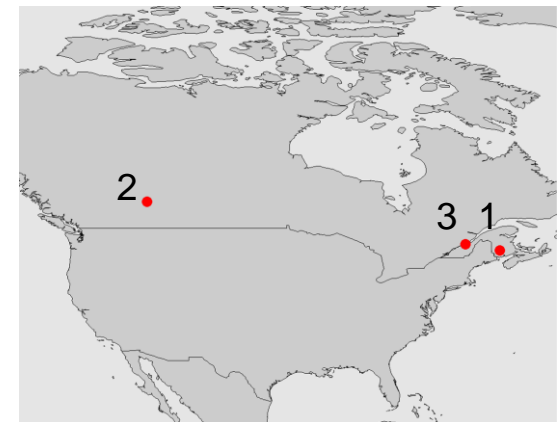
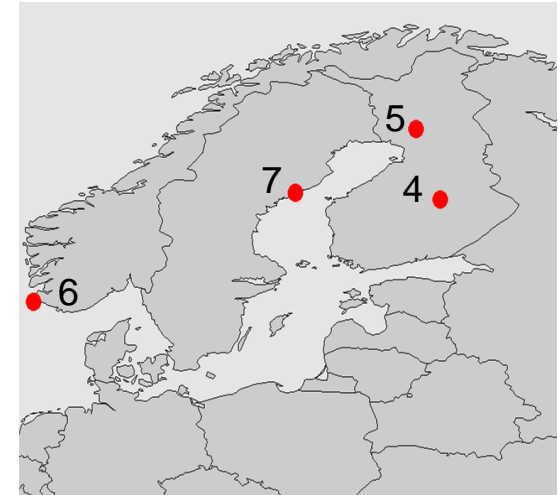
- How can current timothy models predict timothy yields of the first and second cut in northern areas of Europe and Canada where timothy is widely grown?
- Are the models able to predict the timothy yield response to climatic factors and changes in management (e.g. changes in cutting times or N application rates)?
- How do models perform with cultivar-specific vs. non-cultivar specific (generic) calibrations?
- What is the magnitude of uncertainty associated to the yield predictions by different models?

Model comparison setup

- Three models:
 - BASGRA (The BASic GRASsland model, based on LINGRA)
 - CATIMO (CANadian TIMothy MOdel)
 - STICS (Simulateur mulTIdisciplinaire pour les Cultures Standard)

- 7 study sites

Country and site name	Treatments (calibration+test)	
Canada		
1. Fredericton	6 (4+2)	(different N levels)
2. Lacombe	2 (2+0)	
3. Quebec	9 (6+3)	(different N levels)
Finland		
4. Maaninka	2 (2+0)	
5. Rovaniemi	6 (4+2)	(different N levels)
Norway		
6. Saerheim	6 (4+2)	(early and late cut)
Sweden		
7. Umeå	2 (2+0)	



Altogether ~1500 observations of dry-matter yield (also for leaf and stem fractions), crop height, leaf area index and specific leaf area.

Calibrations

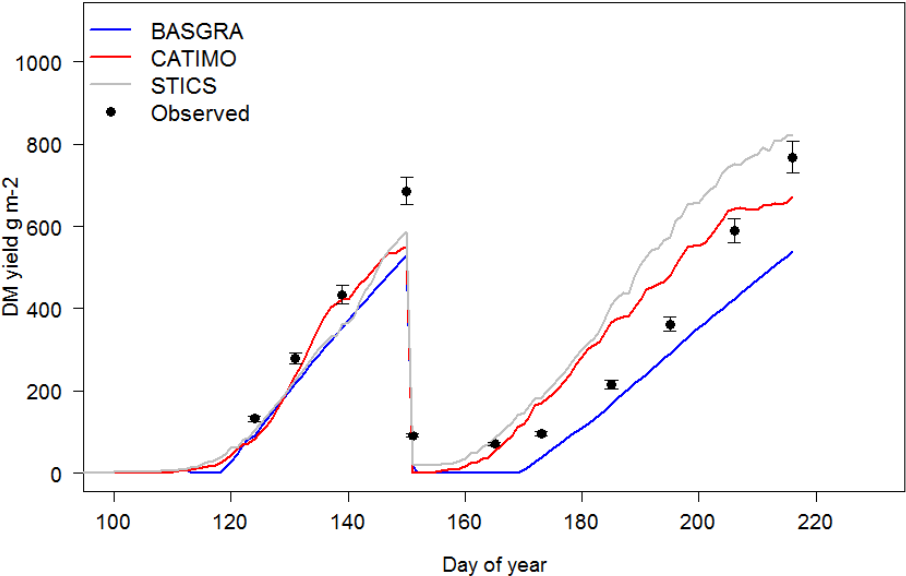
- Model users were free to use preferred calibration method
 - BASGRA and CATIMO applied Bayesian calibration
 - STICS was calibrated using the integrated optimization tool (simplex algorithm)
- Data from 24 treatments were used for calibration and the remaining 9 treatments were used to assess model performance
- Two different calibrations
 - Cultivar-specific calibration
 - Generic calibration applying data from all sites and cultivars

Study site	Cultivar	Years
Fredericton, Canada	Champ	1991-1993
Lacombe, Canada	Climax	2004-2005
Quebec, Canada	Champ	1999-2001
Maaninka, Finland	Tammisto II	2006-2007
Rovaniemi, Finland	Iki	1999-2001
Særheim, Norway	Grinstad	2000-2002
Umeå, Sweden	Jonatan	1995-1996

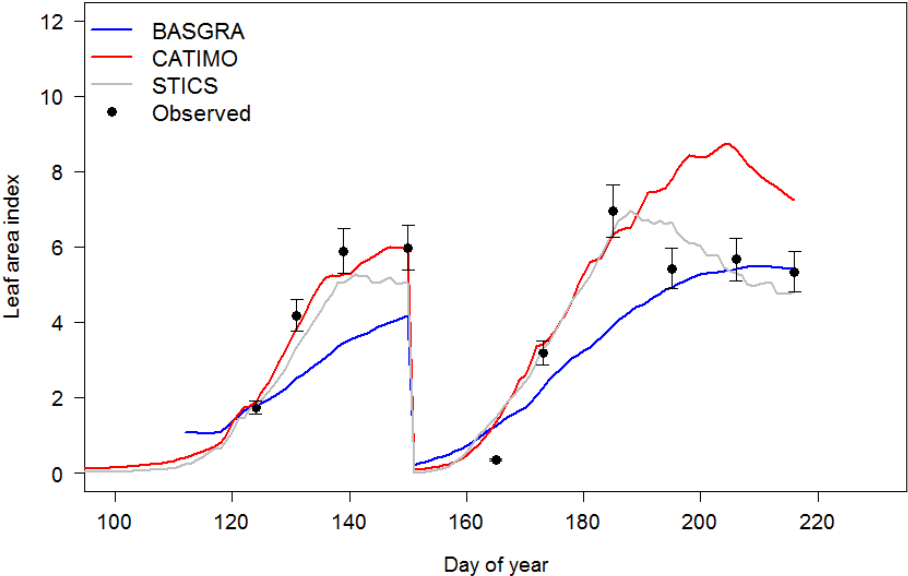
Simulated and observed time course of dry-matter accumulation and leaf area index

Example: Særheim, Norway, year 2000

Dry matter yield

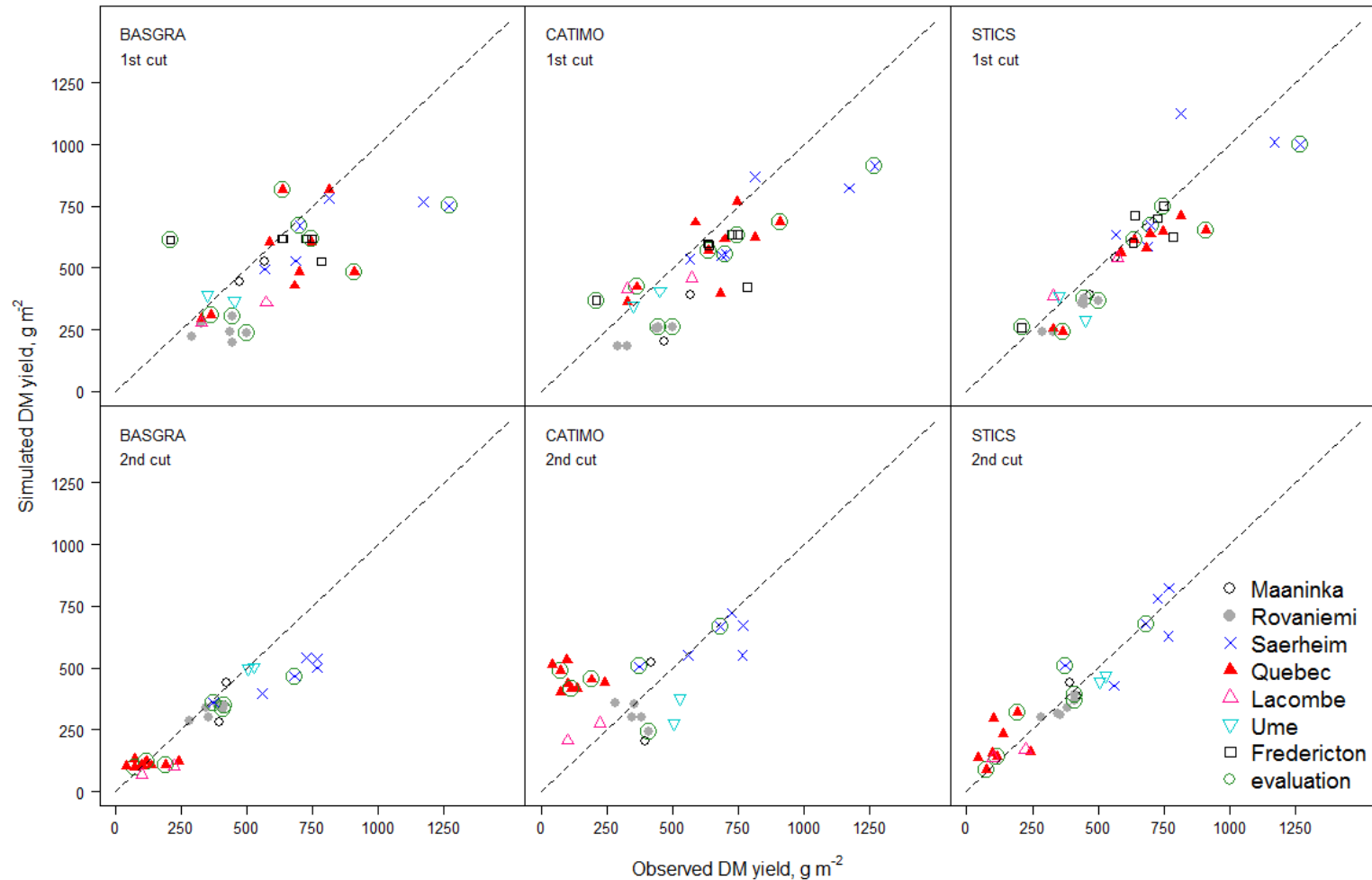


Leaf area index

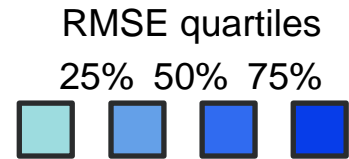


Model performance for the 1st and 2nd cuts

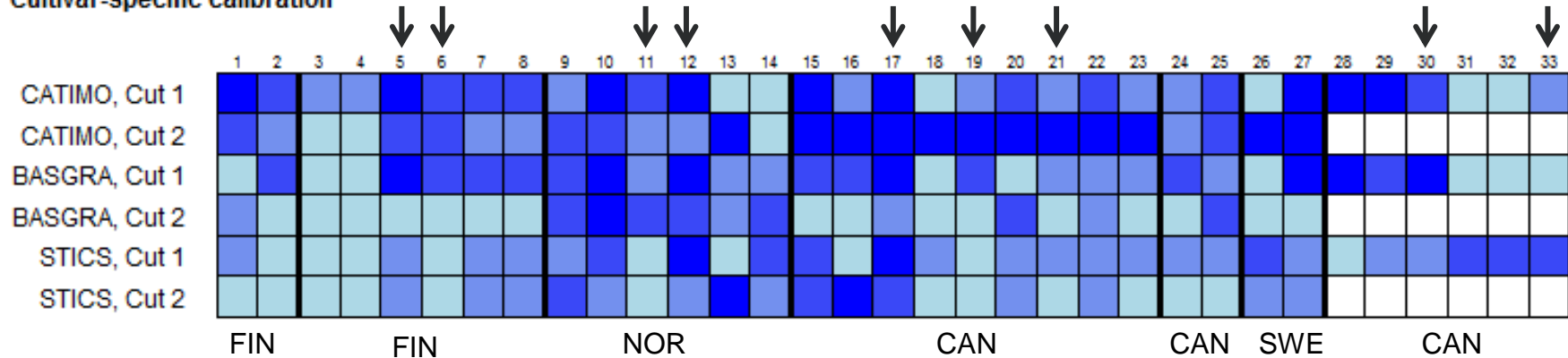
Simulated and observed maximum yields of the 1st and 2nd cut of each treatment using cultivar-specific calibration



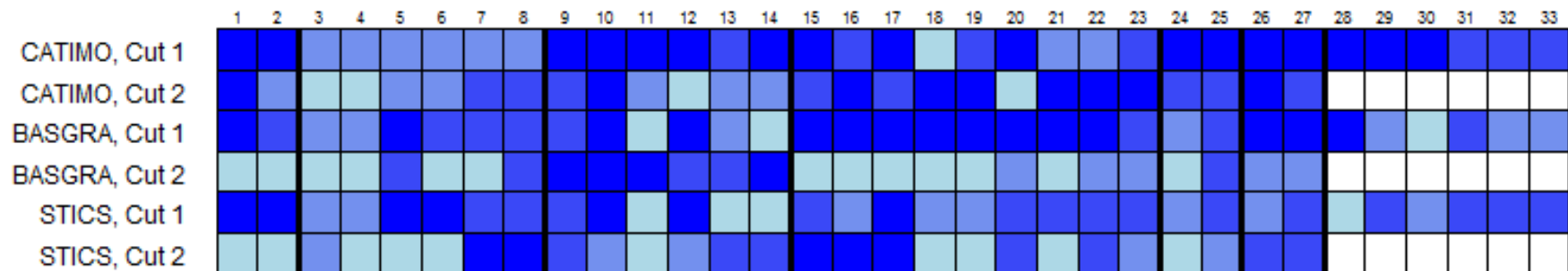
Cultivar-specific vs. generic calibration



Cultivar-specific calibration



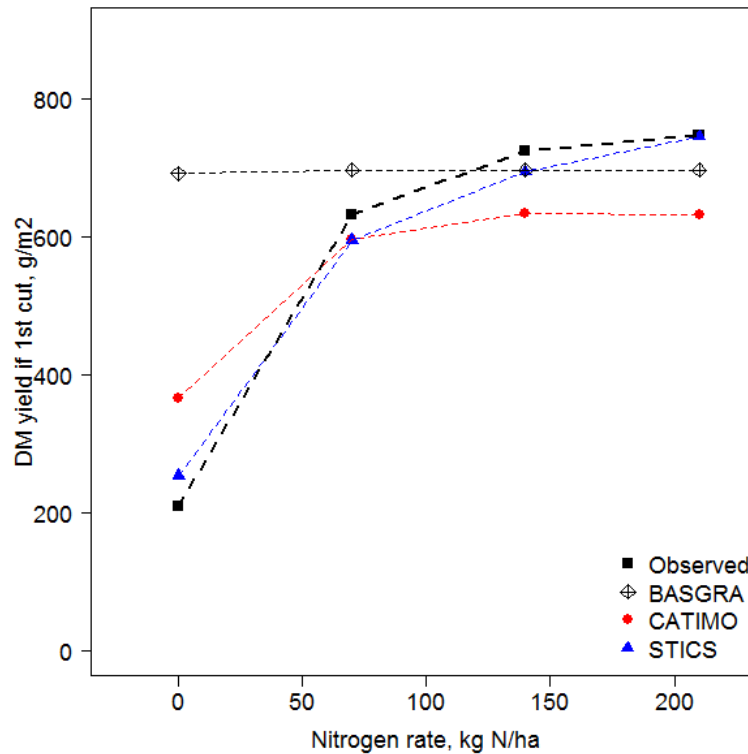
Generic calibration



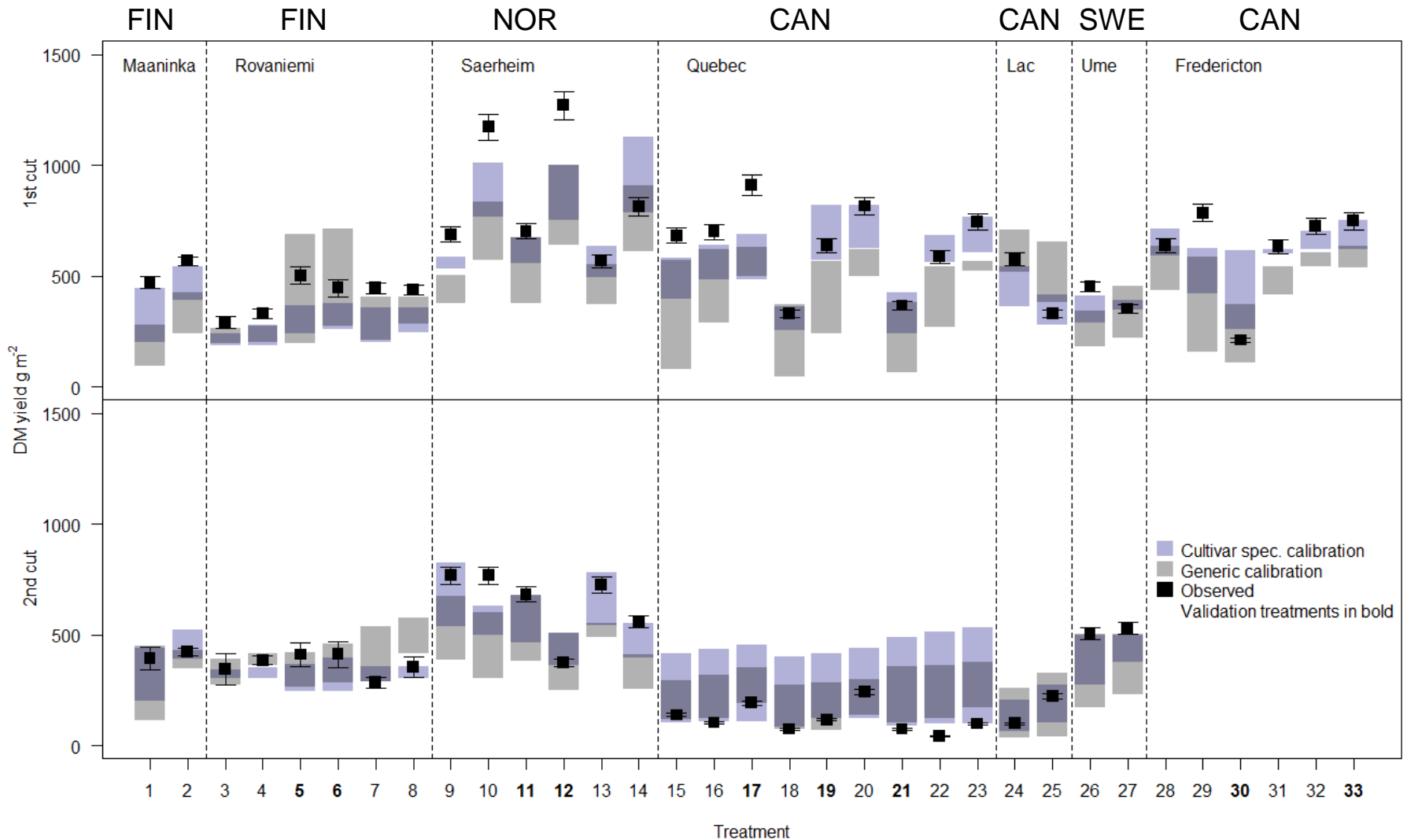
Arrows depict treatments used to assess model performance (not included in calibration).

Yield responses to N levels

Fredericton, year 1993, Cultivar-specific calibration



Uncertainty related to model predictions



Discussion

- All models generally managed to estimate the DM yields satisfactorily and none of them worked clearly better than the others at all sites.
- Cultivar-specific calibration provided better simulation accuracy than the generic calibration. Calibration effect on simulated yields varied among sites and treatments.
- Models differed in their ability to simulate a response to nitrogen fertilization.
- Uncertainties in simulated yield estimates in models are still quite wide and they are related to deficiencies in models process descriptions, uncertainties in model parameters and input data.

Next steps

- MACSUR2 LiveM task 1.2 - grassland quality modelling
 - Model survey of how current grass growth models simulate the nutritive value of forage grasses is currently going on
 - Related workshop to be held in connection with EGF 2016 in Trondheim (Norway) in September
 - Contact panu.korhonen@luke.fi if you want to join in or need more information!
 - Hopefully leads to model comparison paper
- Results will be used to improve models:
 - CATIMO: Regrowth functions will be updated soon
 - BASGRA: Ongoing work to improve N responses
 - STICS: Planned upgrades to better simulation of plant reserve dynamics for improved regrowth and multiannual simulations

Thank you!